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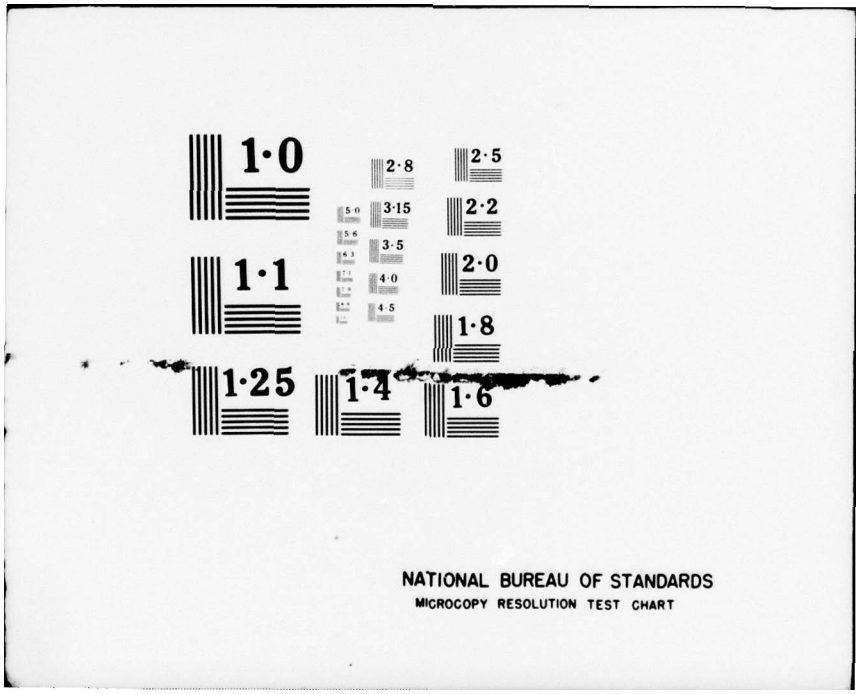
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Evaluation of Planning for Fish & Wildlife

Lake Sharpe
Reservoir Project
October 1976

Department of the Army
Office of the Chief of Engineers
Washington, D.C. 20314

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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Planning evaluation
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Wildlife resources
Preimpoundment predictions
Postimpoundment occurrences

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Lake Sharpe was authorized in 1944 as part of the Pick-Sloan plan for the comprehensive development of the Missouri River Basin. The dam is located at the upstream terminus of Lake Francis Case and the Lake Sharpe headwater extends to the tailwater of Oahe Dam and Reservoir, near Pierre, South Dakota. The existing project totals 32,353 ha including a 22,582 ha conservation pool. → cont on p 1473B

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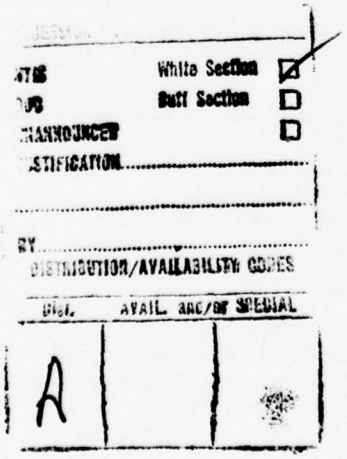
20. Abstract (Con't)

Implementation of the FWS's land acquisition plan for wildlife mitigation was encumbered by the location and extent of Indian lands and the unwillingness of the Indians to sell. Land acquisition was further handicapped by procedural disagreements between the State and the construction agency. As a result, the 1,174 ha wildlife management area recommended by the FWS to mitigate wildlife losses was not acquired at the Lake Sharpe project. Fish and wildlife resources associated with the project have developed incidentally to authorized project purposes.

The FWS expected the Lake Sharpe project to benefit fishery resources and improve waterfowl habitat and waterfowl hunting while substantially reducing other wildlife populations. The current evaluation was made difficult by the lack of site-specific pre and post construction documentation of project associated wildlife populations and hunter utilization values. Waterfowl use of Lake Sharpe proper, and the entire four-reservoir Missouri River complex proved to be of greater magnitude than was predicted by the FWS. This has occurred in the absence of the 1,174 ha wildlife management area requested by the FWS.

A complete loss of big game hunting in the vicinity of the reservoir, as predicted by the FWS, was not substantiated by the available county-by-county hunting pressure and harvest data available. Insufficient data were available to assess the validity of predicted quantitative changes within the upland game community.

Treatment of the fishery aspects of the Lake Sharpe project was not adequate. All quantitative angler-use predictions were based upon the erroneous assumption that a trout fishery would develop in Lake Sharpe. Based on a one-year creel survey (1973-1974), the coolwater fishery of Lake Sharpe that subsequently developed, attracted approximately 68,046 fishermen trips, some 39 percent fewer trips than the pre-impoundment prediction of 111,000 trips projected on the basis of a trout fishery. The paddlefish population of the Missouri River appears to have been adversely impacted as predicted by the FWS.



PREFACE

This document was prepared by staff of the Sport Fishing Institute for the U.S. Army Corps of Engineers (CE) under contract number DACW73-74-C-0040. The contract requires the compilation and comparison of pre- and post-construction data treating fish, wildlife, or both fish and wildlife (depending upon data availability) for twenty separate CE water development projects. This report presents the findings for one of the twenty individual project evaluations.

Upon completion of the full series of twenty separate studies, a final report will be prepared which will contain an analysis of the validity of the predictive procedures used in fish and wildlife planning, and will contain recommendations for improving the planning process.

The Sport Fishing Institute staff could not have completed the Lake Sharpe (Big Bend Dam) project evaluation without the assistance and cooperation of a number of agencies and individuals. Post-impoundment fish and wildlife data were provided by Harvey H. Pietz and Robert Hanten (South Dakota Department of Game, Fish and Parks) and by Fred June (North Central Reservoir Investigations, U.S. Fish and Wildlife Service). Pre-impoundment, historical documentation was provided by Gilbert Key and Bruce Stebbings (Division of Ecological Services, U.S. Fish and Wildlife Service) and by David Billman (Missouri River Division, U.S. Army Corps of Engineers).

Personnel in the environmental planning and recreation management elements of Corps agencies should review this report with view towards improvement of Corps activities.

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SPORT FISHING INSTITUTE

PROJECT PERSONNEL

Norville Prosser (Assistant Project Leader)

Robert Martin (Project Leader)

Richard Stroud (Contractor's Representative)

CONSULTANT'S REVIEW

The interpretations of terrestrial wildlife aspects by project personnel were submitted in draft report form for review and evaluation by specialists on the staff of the Wildlife Management Institute. Their evaluation was accomplished solely on the basis of facts presented in the manuscript without benefit of supplemental field reconnaissance. All suggestions of substance offered by the consultant are reflected in this report.

INDIVIDUAL RESERVOIR PROJECT EVALUATION REPORTS

THE LAKE SHARPE (BIG BEND DAM) RESERVOIR PROJECT

INTRODUCTION

Location

Lake Sharpe, located in the Missouri River Division's Omaha District, was formed on the Missouri River between Fort Thompson and Pierre, South Dakota, by construction of the Big Bend Dam. The dam is located at the upstream terminus of Lake Francis Case and the Lake Sharpe headwater extends to the tailwater of Oahe Dam and Reservoir near Pierre, South Dakota. Lake Sharpe is located in Buffalo, Lyman, Hyde, Hughes, and Stanley Counties. Pierre, with a 1970 population of 9,699, is the only community within 121 km (75 mi) of the reservoir mid-point with a population of 5,000 people or more. Big Bend Dam is located approximately 32 km (20 mi) from Interstate Route 90 and is accessible by State Routes 47 and 34. About two-thirds of Lake Sharpe is located in Indian reservations. The Crow Creek Indian Reservation is located on the north side of the reservoir and the Lower Brule Indian Reservation is located on the south side of the reservoir. A map of the project area is presented in Figure 1.

Authorization

Six main-stem reservoirs, including Lake Sharpe, were authorized by the Flood Control Act of December 22, 1944, as part of the Pick-Sloan plan for the comprehensive development of the Missouri River Basin. The primary purpose for construction of Lake Sharpe was to provide hydroelectric power. Other project purposes included flood control, navigation, and recreation.

Physical Features

At conservation pool elevation 433 m (1,420 ft) mean sea level (msl),

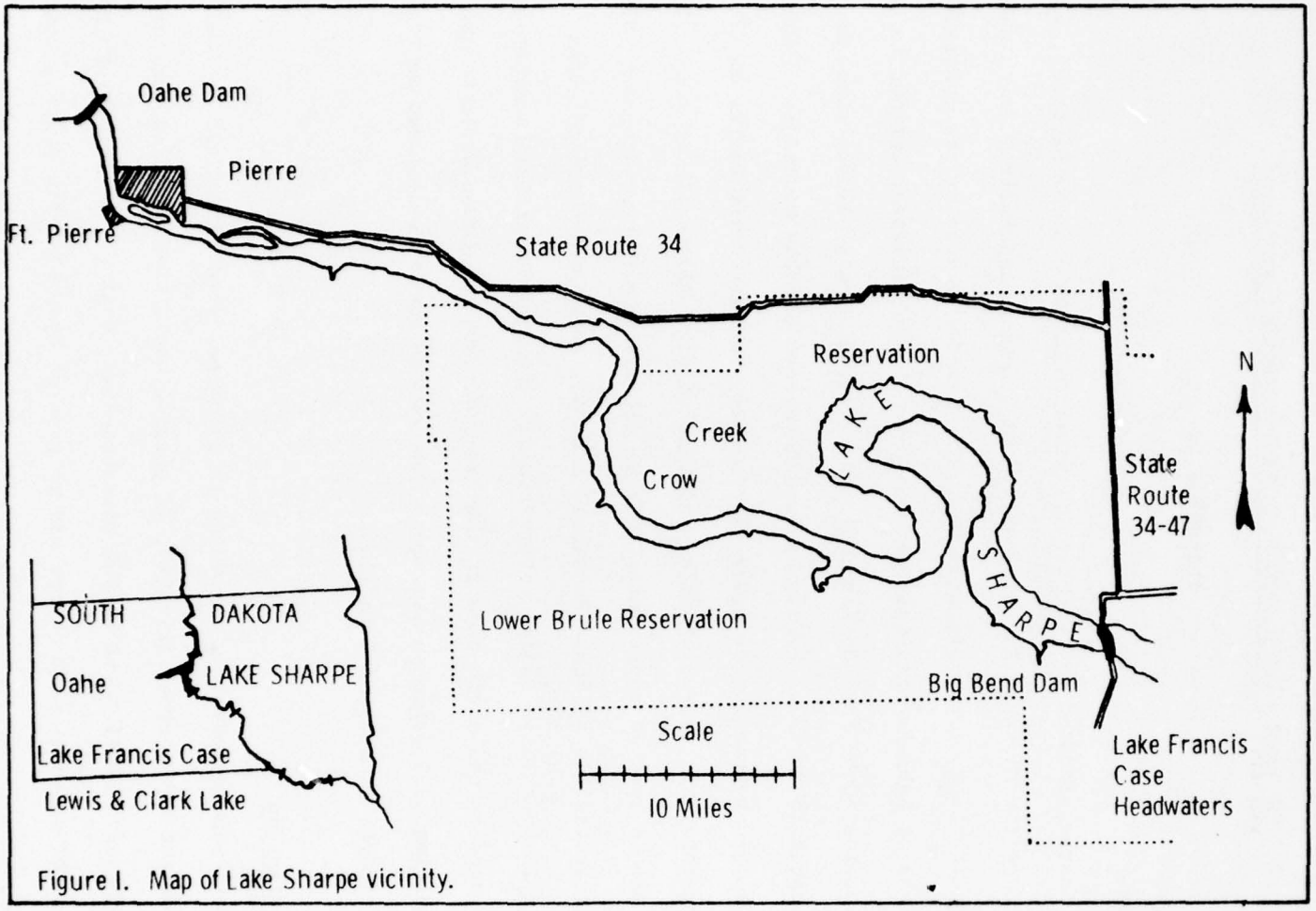

Figure I. Map of Lake Sharpe vicinity.

Lake Sharpe covers 22,582 ha (55,800 ac) and extends 129 km (80 mi) upstream from Big Bend Dam to the vicinity of Pierre, South Dakota. At conservation pool elevation, the shoreline is approximately 323 km (200 mi) in length. An additional 1,821 ha (4,500 ac) are inundated at full flood pool. Average width of the conservation pool is 1.6 km (1 mi). Reservoir storage capacity is 2.34×10^9 m^3 (1.9 million ac-ft) at full pool (1).

Water level fluctuations in the main reservoir seldom vary by more than 0.3 m (1 ft) although, near the Oahe tailrace, daily fluctuations of 2 m or more occur (2). Some 32,353 ha (79,942 ac), including 9,770 ha (24,142 ac) above conservation pool, are included in the Lake Sharpe project. If uniformly distributed, this would approximate a buffer strip averaging 305 m (1,000 ft) in width.

Area Description

Prior to project construction, the flood plain of the Missouri River was confined between high-walled terraces to a width of 3 to 6 km (2 to 4 mi) and was depressed approximately 90 to 120 m (300-400 ft) below the surrounding terrain. The only woody cover within the project site was limited to the flood plain, including several wooded islands in the river. The principal woody species was cottonwood, with an understory of juniper, rose, snowberry, dogwood, willow, and other shrubby species (3).

Above the flood plain, the topography is gently rolling glaciated upland on the east side and broken hills of erodible Pierre shale on the west side. Agricultural use of the uplands is more intensive on the east bank and most of the west side is used for livestock grazing. Waters from Lake Sharpe have been increasingly diverted for irrigation and the irrigated

acreage has steadily increased.

Descriptive Reports

Lake Sharpe was the largest Corps of Engineers reservoir constructed in the last 20 years that was found to be supported by adequate pre-impoundment fish and wildlife planning data (including predicted post-impoundment occurrences) together with post-impoundment fish and wildlife follow-up studies to permit comparative evaluations (4).

Specific sources of pertinent data which were visited during the Lake Sharpe investigation included: National Archives in Washington, D.C.; South Dakota Game, Fish and Parks Department in Pierre, South Dakota; U.S. Fish and Wildlife Service's Ecological Services office in Pierre, South Dakota; U.S. Fish and Wildlife Service's North Central Reservoir Investigation Field office in Pierre, South Dakota; and the Corps of Engineers Environmental Resources Branch of the Missouri River Division, Omaha, Nebraska.

Cooperative planning between the FWS and the CE for purposes of mitigating fish and wildlife resources at the Lake Sharpe project was initiated in April, 1958. Several preliminary reports preceded the FWS planning report of 1962. The initial FWS planning document was submitted to the construction agency on November 5, 1958 (5). In this letter, the FWS recommended consideration of two major development features for fish and wildlife mitigation: (1) construction of 80 acres of fish rearing ponds in the area below the dam, and (2) acquisition for fish and wildlife management purposes of four tracts of land totaling 21,400 acres.

Subsequently, the CE modified the engineering design of the project (including proposing a larger normal pool). In response, the FWS submitted a

revised fish and wildlife report, dated January 9, 1959 (6). This report recommended that 26,700 acres of land be authorized for purchase for fish and wildlife management to mitigate the expected loss of wildlife habitat. Of the 26,700 acres specifically recommended for acquisition, 20,200 acres were located within the two Indian reservations. Because of a change in the position of the dam, the rearing-pond recommendation was deleted from the 1959 report.

In the following months, there were many discussions between the FWS and the affected Indian Tribes regarding acquisition of these Indian reservation lands. These negotiations failed to produce an accord as the Indians refused to sell any reservation lands for wildlife management purposes (7). As a consequence, the FWS scaled down their mitigation plan and prepared and submitted their final planning report on December 26, 1962 (3). Evaluation of the specific recommendations and predictions contained in this 1962 report constitute the subject of this analysis.

Post-impoundment wildlife evaluations have been conducted for several consecutive years by the SDGFPD. Except for certain waterfowl-count data, these studies have not, however, been directed specifically at the reservoir or associated project lands. Wildlife harvest and hunting pressure data have been collected by postal questionnaires. These annual statistics are available for each South Dakota county. Fisheries investigations have been conducted at irregular intervals since impoundment of Lake Sharpe. During 1973-1974, a complete creel survey of the reservoir and tailwater was completed as a graduate degree program at the South Dakota Cooperative Fisheries Unit, South Dakota State University, Brookings, South Dakota.

WILDLIFE RESULTS AND DISCUSSION

Waterfowl Resources -- Pre-impoundment Predictions

Waterfowl resources associated with the free-flowing Missouri River in the Lake Sharpe construction site were described briefly in the 1962 letter-report (3) as follows:

> Waterfowl, particularly geese, are the most important wildlife using this section of the river. They are found throughout the area during migration perods, but the Big Bend Area, the De Grey-La Roche Area, and Antelope Island are the principal concentration points. Some of the best goose hunting in South Dakota is found in this vicinity, and hunters are attracted from all parts of the state.

The lengthier substantiating section of the 1962 FWS planning report outlined the waterfowl utilization of this section of river in these quantitative terms:

> Large numbers of waterfowl use the reservoir during spring and fall migration periods, and there is some use of the area by breeding waterfowl. The Canada goose is the most common of those utilizing the area. Blue, snow, and white-fronted geese make up less than 5 percent of the goose population. Aerial waterfowl counts have been made on the area during the fall migration periods since 1948. The largest number of geese counted at one time was 7,250 in the fall of 1948. About 177,000 goose-days are spent on the area annually. This is approximately 2,000 goose-days per stream mile which compares to approximately 800 days per stream mile for Oahe Reservoir Area and Lewis and Clark Lake, and 11,000 days per mile on Fort Randall Reservoir. An estimated 3,300 goose hunter-days are expended annually on the reservoir area. Goose kill is estimated to average about 800 birds annually.
>
> Use of the reservoir area by ducks is low compared to use of other main-stem reservoirs and reservoir areas. An average of 750 duck-days per year are spent per stream mile on the area. This compares with approximately 3,300 on Oahe Reservoir Area, 7,300 on Lewis and Clark Lake, and 36,000 on Fort Randall Reservoir. Most of the ducks using the area are mallards, which furnish some field shooting, but much of the duck shooting is passed up in order not to disturb the geese. The Missouri River in South Dakota is a game refuge, so shooting is restricted to flocks feeding on outlying areas. An estimated 700 hunter days are expended annually in harvesting 2,000 ducks from the area.

Construction of the reservoir was expected to cause a significant impact on the waterfowl resources of the project area. The 1962 FWS letter-report contained the following comments:

> The impoundment is expected to have a significant effect on the distribution of migratory waterfowl. With all main-stem reservoirs in operation, use by both ducks and geese is expected to be more evenly distributed among the reservoirs than it is now. Waterfowl, especially geese, formerly occupying other areas in the State will remain in the Big Bend area in large numbers during migration, both spring and fall. Wintering flocks will be larger. With this redistribution of waterfowl, the Big Bend Reservoir area is expected to attract an increasing number of goose hunters. This increase is expected to be about 2,600 hunter-days annually. While the use of the reservoir by ducks is expected to increase slightly over use of the river, no significant change in the use by duck hunters is expected.

A more elaborate, and detailed presentation of the project's expected impact on waterfowl was contained in the substantiating section of the 1962 report, viz:

> The impoundment is expected to have a substantial effect on the distribution of migratory waterfowl. With all main-stem reservoirs in operation, use by geese and ducks will be more evenly distributed between the reservoirs than it is now. This probably will result in an increase in waterfowl use of Oahe and Big Bend Reservoirs and a decrease in use of Fort Randall Reservoir. The magnitude of this change is difficult to estimate. Since Big Bend Reservoir will be somewhat centrally located and the availability of food will be somewhere between that at Oahe and Fort Randall the average goose use for Big Bend Reservoir after impoundment is estimated at 3,500 goose-days per stream mile or a total of 280,000 goose-days per year. This is the average use for main-stem reservoirs in South Dakota. This will be a substantial increase in the use of this section of the valley by geese and will occasion the need for more intensive management. Development of feeding and waterfowl management areas will be needed to realize the full potential of the reservoir.
>
> It is estimated that after impoundment the goose harvest will increase to 1,400 annually, and 5,900 additional hunter-days for geese will develop. Migratory duck use of Big Bend Reservoir Area is expected to increase slightly with impoundment, but, with the emphasis expected to be on goose hunting, the increase in duck kill and duck hunter days is not expected to be of great significance.

The substantiating section also included the following short section relating to non-game species of water birds:

> All habitat for a wide variety of small birds will be inundated by the reservoir, and many acres of nesting habitat will be lost. Sandhill cranes are not expected to be affected to any great extent, but sandbars used during migration will be lost. The large expanse of water, and in some cases the flooded timberlands, will provide new habitat for white pelicans cormorants, gulls, and other water birds.

To mitigate wildlife losses associated with the Lake Sharpe Reservoir project, the FWS recommended development of a management area, partially to reduce the loss to upland game, but primarily to increase waterfowl hunting opportunities.

In the formal report, the FWS recommended the development of one tract in the De Grey area as a State wildlife management area. The proposed development was entirely outside the boundaries of the Indian reservations and consisted of 2,960 acres, 300 acres of which were within the proposed project boundary. Acquisition of the additional 2,660 acres and fencing of the 11-mile boundary of the 2,960 acre management area were recommended by the FWS.

Two additional recommendations were made by the FWS: (1) the plan for development of public use areas around the reservoir, as proposed by the CE, be adopted and implemented, and (2) that selected project lands, including those in the management areas, be made available to the SDGFPD for adminstration under a General Plan.

Procedures used to develop specific waterfowl-related estimates contained in the FWS predictive report were outlined in the basic data files (8). The FWS estimates of the goose use for the various sections of the Missouri River main-stem were developed from weekly survey data collected by the

SDGFPD. Table 1 presents the average empirical aerial goose counts for the period considered by the FWS in their pre-impoundment report (1953-1959) and the total goose visitation estimates developed by the Service from these weekly counts. The empirical aerial counts are reproduced from a SDGFPD Pittman-Robertson report (9), and the expanded day-use estimates of the FWS appeared in that agency's basic data files. The post-impoundment goose-use prediction for Lake Sharpe was estimated simply by computing an arithmetic average of the pre-impoundment goose-use per mile for the four distinct reservoir-related areas and multiplying this average value by the length in miles of Lake Sharpe, (i.e., 3,500 goose-days/mi x 80 mi).

In addition to the FWS goose-use estimate for the period 1953-1959, pre-construction total goose-use estimates for the main-stem Missouri River were also available from SDGFPD's own expansions of their aerial flight data (9-11). These State estimates were available for each year beginning in 1959 for Gavins Point and Fort Randall and beginning in 1962 for Big Bend and Oahe. The State's aerial counts and expanded goose-use estimates for the years prior to the inundation of Lake Sharpe (1964) are presented in Table 2. These data show that the most intensive goose-use occurred on Fort Randall with an average of 5,300 goose-days per mile for the years 1959 through 1963. Total goose-use estimates by both FWS and SDGFPD were available for Gavins Point and Fort Randall for 1959. Significant differences exist between these estimates. On the average, the FWS estimates were 2.1 times greater than the State estimates.

Pre-construction duck-day use estimates were also developed by the FWS from the SDGFPD aerial flight data. These FWS-developed statistics (as

Table 1.--Average empirical counts, and expanded total estimates of the goose use of four reservoir related sections of the main stem Missouri River, South Dakota. Figures represent fall and winter use of the river and/or reservoirs for the period 1953 to 1959

Year	Gavins Point (Lewis & Clark Lake)			Fort Randall (Lake Francis Case)			Big Bend (Lake Sharpe)		
		Expanded			Expanded			Expanded	
	Empirical count	Total goose-days	Goose-days/ mile	Empirical count	Total goose-days	Goose-days/ mile	Empirical count	Total goose-days	Goose-days/ mile
1953	184	11,312	149	14,030	1,596,161	14,380	2,902	225,295	2,476
1954	6	315	4	14,496	897,540	8,086	3,195	170,037	1,869
1955	420	323,029	4,250	22,436	1,283,786	11,566	1,199	71,176	782
1956	498	36,512	480	8,152	699,545	6,302	1,562	121,212	1,332
1957	216	19,425	256	10,601	1,131,802	10,196	2,996	204,351	2,246
1958	146	25,543	336	12,547	1,268,421	11,427	3,296	225,722	2,480
1959	130	27,594	363	13,913	1,390,039	12,523	2,755	222,789	2,448
Average	229	63,390	834	13,739	1,181,042	10,640	2,558	177,226	1,948

Table 1 .-- (Continued)

Year	Oahe			Total		
		Expanded			Expanded	
	Empirical count	Total goose-days	Goose-days/ mile	Empirical count	Total goose-days	Goose-days/ mile
1953	3,268	260,659	1,524	20,384	2,093,427	4,662
1954	2,316	133,875	783	20,013	1,201,767	2,677
1955	1,124	68,208	399	25,179	1,746,199	3,889
1956	1,944	132,510	775	12,156	989,779	2,204
1957	2,244	137,354	803	16,057	1,492,932	3,325
1958	1,450	117,173	685	17,439	1,636,859	3,646
1959	2,224	128,940	754	19,022	1,769,362	3,941
Average	2,081	139,817	818	18,607	1,561,475	3,478

Table 2.--SDGFPD aerial goose counts and expanded total goose use estimates for the four reservoir related sections of the Missouri River in South Dakota, prior to inundation of Lake Sharpe

Year	Gavins Point (Lewis & Clark Lake)			Fort Randall (Lake Francis Case)			Big Bend (Lake Sharpe)		
		Expanded			Expanded			Expanded	
	Empirical count	Total goose-days	Goose-days/ mile	Empirical count	Total goose-days	Goose-days/ mile	Empirical count	Total goose-days	Goose-days/ mile
1959	130	7,118[1]	99[1]	13,913	663,107[2]	5,921[2]	2,755	NR[3]	NR
1960	109	3,304	46	11,831	741,541	6,621	3,959	NR	NR
1961	151	7,416	103	12,099	654,529	5,844	3,894	NR	NR
1962	147	6,720	93	6,861	453,535	4,049	2,806	192,337	2,186
1963	107	5,371	75	9,516	455,095	4,063	1,965	109,289	1,242
Average	129	5,986	83	10,844	593,561	5,300	3,076	150,813	1,714

Table 2.-- (Continued)

Year	Oahe			Total		
		Expanded			Expanded	
	Empirical count	Total goose-days	Goose-days/ mile	Empirical count	Total goose-days	Goose-days/ mile
1959	2,224	NR	NR	19,022	NR	NR
1960	3,046	NR	NR	18,945	NR	NR
1961	5,160	NR	NR	21,304	NR	NR
1962	1,505	100,974	616	11,319	753,566	1,728
1963	2,489	143,006	872	14,077	712,761	1,635
Average	2,485	121,990	744	16,534	872,350	2,001

[1]FWS reported 27,594 goose-days (363 days/mi.) in pre-impoundment basic data.
[2]FWS reported 1,390,039 goose-days (12,523 days/mi.) in pre-impoundment basic data.
[3]NR - not reported in available literature.

extracted from that agency's basic data files) are shown in Table 3. No quantitative projections of post-impoundment duck use or duck hunter days were provided by the FWS for the period following construction of Lake Sharpe.

The basic data files outlined the methods employed by the FWS to develop estimates of goose and duck hunting pressure and harvest estimates for the pre-impoundment and post-impoundment periods. The FWS reviewed South Dakota's Pittman-Robertson documents, and determined that the average number of geese killed in the four counties bordering the Big Bend area was 2,400 birds per year for the period 1948-1952. Upon review of these computations, the SDGFPD reduced the 2,400 figure to 800 geese killed per year. At various times in the planning report development stage, the State provided other goose kill and hunting pressure estimates to the FWS, viz: 600 killed in 2,500 man-days; 900 killed in 7,000 man-days; 800 killed in 7,000 man-days.

The FWS ultimately used the estimated harvest figure of 800 geese but viewed the State's estimate of 7,000 man-days of hunter-use as too high because the resulting success ratio of 0.11 goose killed per hunter day was significantly less than the statewide figure of 0.42. As a result, the FWS staff elected to use the State's estimated ratio of 600 geese killed in 2,500 hunter-days to compute a success rate of 0.24 geese killed/hunter-day. They then divided the accepted estimate of 800 geese killed by the 0.24 goose-hunting success ratio to obtain their pre-impoundment hunting-pressure estimate of 3,300 man-days.

To compute the probable post-impoundment harvest, the FWS staff employed the following simple proportion:

Table 3 .--Estimated duck-day use of four reservoir related sections of the main stem Missouri River, South Dakota prior to Lake Sharpe inundation as computed by FWS from SDGFPD aerial surveys (1953-1959) and as computed by the SDGFPD (1962-1963)

Year	Gavins Point (Lewis & Clark Lake)		Fort Randall (Lake Francis Case)		Big Bend (Lake Sharpe)		Oahe		Total	
	Total duck-days	Duck-days/ mile	Total duck-days	Duck-days/ mile	Total duck-days	Duck-days/ mile	Total duck-days	Duck-days/ mile	Total duck-days	Duck-days/ mile
1953	17,872	235	2,656,839	23,935	59,465	653	560,285	3,277	3,294,461	7,337
1954	3,223	42	1,601,272	14,426	16,030	176	266,634	1,559	1,887,159	4,203
1955	622,675	8,193	2,982,288	26,867	17,667	194	345,163	2,018	3,967,793	8,837
1956	860,479	11,322	3,032,225	27,317	43,559	479	154,222	902	4,090,485	9,110
1957	1,090,638	14,350	8,185,189	73,740	216,190	2,376	1,660,481	9,710	11,152,498	24,839
1958	1,042,515	13,717	7,967,856	71,782	112,914	1,241	861,811	5,040	9,985,096	22,239
1959	223,146	2,936	1,613,754	14,538	15,200	167	65,901	385	1,918,001	4,272
Average	559,212	7,256	4,005,631	36,086	68,718	755	559,214	3,270	5,192,775	11,565
1962	460,000	6,389	1,889,000	16,866	33,000	375	4,500,000	27,439	6,882,000	15,784
1963	543,000	7,542	4,222,000	37,696	383,000	4,352	5,091,000	31,043	10,239,000	23,484
Average	501,500	6,965	3,055,500	27,281	208,000	2,364	4,795,500	29,241	8,560,500	19,634

$$\frac{\text{1,948 goose-days/mile (pre-impoundment)}}{\text{3,478 goose-days/mile (post-impoundment)}} = \frac{\text{800 geese harvested (pre-impoundment)}}{X}$$

Where, X = estimated post-impoundment goose harvest.

Solving the equation provided an estimated post-impoundment harvest figure of 1,428 geese. The FWS estimated that total post-impoundment goose hunting would amount to 5,950 man-days by simply dividing the estimated kill figure of 1,428 by the same success rate assumed for the pre-impoundment period, i.e., 0.24 geese killed/hunter day.

Waterfowl Resources -- Post-impoundment Occurrences

The land acquisition proposal which was submitted to the CE by the FWS to mitigate wildlife losses associated with the project, was never implemented. This plan proposed the acquisition of approximately 2,660 acres of land in the De Grey area. This tract was to be combined with 300 acres of land purchased by the CE for primary project purposes, to establish a State-administered wildlife management area. Neither the State nor the CE questioned the merits of the technical recommendations of the FWS.

The State, however, conditionally endorsed the land acquisition plan, to the extent that "land acquisition be accomplished by the U.S. Army Corps of Engineers only from willing sellers." This condition was considered technically unsound by the CE, as they believed land acquisition expenses would be almost perpetual and disproportionate to the market value of the land due to the need for extended and frequent landowner contacts, reappraisals, etc. (1).

The CE assumed the position that modification of the project to permit acquisition of land for wildlife purposes would be contingent upon the SDGFPD withdrawing their opposition to land acquisition by condemnation (12). As a result of the land acquisition procedural disagreements, the CE never sought Congressional authorization to incorporate the FWS recommendations at the Lake Sharpe project. The FWS estimates and predictions never became part of project-related cost-benefit computations. As a result, land was not acquired specifically for wildlife management purposes at the Lake Sharpe project.

Since the impoundment of Lake Sharpe, the SDGFPD has continued to document migratory waterfowl use of the Missouri River reservoirs by employing fall and winter aerial counts. Pittman-Robertson reports summarizing the empirical counts and the expanded estimates of goose-use for the years 1964 through 1973 (9,11,13,14) were employed to prepare Table 4. Average total goose-use of the 436 miles of South Dakota impoundments, during the 8-week survey period, was 3,642 goose-days/mile according to these data. Fort Randall was the most intensively used reservoir (6,688 goose-days/mi) and Lake Sharpe (5,453 goose-days/mi) was second with approximately 20 percent less goose-use than was experienced at Fort Randall.

Post-impoundment utilization of Lake Sharpe by ducks was also enumerated during the aerial surveys conducted by the SDGFPD. The duck-day use figures presented in Table 5 for the four reservoir chain, were developed from graphs presented in SDGFPD Pittman-Robertson reports (9,11,13,14). These data show that use of the four-reservoir chain since impoundment of Lake Sharpe has been relatively stable, averaging approximately 10,000,000 duck-days annually during the eight-week fall and winter survey period.

Table 4 .--Average number of geese counted/weekly flight and expanded estimate of total goose-days use of four main stem Missouri River reservoirs in South Dakota following completion of Lake Sharpe. Counts were made by SDGFPD for eight consecutive weeks beginning on or near October 10

Year	Gavins Point (Lewis & Clark Lake)			Fort Randall (Lake Francis Case)			Big Bend (Lake Sharpe)		
	Empirical count	Expanded Total goose-days	Expanded Goose-days/ mile	Empirical count	Expanded Total goose-days	Expanded Goose-days/ mile	Empirical count	Expanded Total goose-days	Expanded Goose-days/ mile
1964	157	6,208	86	11,851	674,061	6,018	5,979	345,157	3,922
1965	*	*	*	10,386	573,894	5,124	6,759	381,271	4,333
1966	6**	304	4	11,256	675,432	6,031	4,946	273,515	3,108
1967	51**	3,248	45	12,554	793,760	7,087	5,357	301,125	3,422
1968	19	1,426	20	12,523	681,552	6,085	6,141	343,896	3,908
1969	47	2,380	33	16,330***	869,995	7,768	8,851***	433,650	4,928
1970	270	8,610	120	11,634	640,889	5,722	7,575	436,788	4,964
1971	401	26,152	363	20,020	886,932	7,919	11,037	533,400	6,061
1972	56***	2,933	41	13,658	752,906	6,722	11,832	669,207	7,605
1973	202***	14,441	201	20,758***	940,928	8,401	18,841	1,080,597	12,280
Average	151	7,300	101	14,097	749,035	6,688	8,732	479,861	5,453

Table 4 .-- (Continued)

Year	Oahe			Total		
	Empirical count	Expanded Total goose-days	Goose-days/ mile	Empirical count	Total goose-days	Goose-days/ mile
1964	1,436	81,365	496	19,423	1,106,791	2,539
1965	*	*	*	*	*	*
1966	2,608**	148,206	904	18,816	1,097,457	2,517
1967	2,985**	167,146	1,019	20,947	1,265,279	2,902
1968	4,671	265,489	1,619	23,354	1,292,363	2,964
1969	7,955	432,076	2,635	33,183	1,738,101	3,986
1970	5,658	313,505	1,912	25,137	1,399,792	3,211
1971	7,721	421,662	2,571	39,179	1,868,146	4,285
1972	11,102	605,088	3,690	36,648	2,030,134	4,656
1973	13,559***	731,951	4,463	53,360	2,767,917	6,348
Average	6,411	351,832	2,145	29,391	1,588,028	3,642

*Not censused.

**Only four counts made but average figured for eight flights.

***Only seven counts made but average figured for eight flights.

Table 5. --Estimated duck-day use of four reservoir related sections of the main stem Missouri River, South Dakota prior to Lake Sharpe inundation as computed by SDGFPD

Year	Gavins Point (Lewis and Clark Lake)		Fort Randall (Lake Francis Case)		Big Bend (Lake Sharpe)		Oahe		Total	
	Total duck-days	Duck-days/ mile	Total duck-days	Duck-days/ mile	Total duck-days	Duck-days/ mile	Total duck-days	Duck-days/ mile	Total duck-days	Duck-days/ mile
1964	1,071,000	14,875	4,296,000	38,357	1,000,000	11,364	3,682,000	22,451	10,049,000	23,048
1965	*	*	3,300,000	29,464	1,116,000	12,682	*	*	*	*
1966	1,360,000	18,889	4,130,000	36,875	1,610,000	18,295	5,114,000	31,183	12,214,000	28,014
1967	1,243,000	17,264	2,580,000	23,036	1,446,000	16,432	6,273,000	38,250	11,542,000	26,472
1968	810,000	11,250	5,250,000	46,875	2,635,000	29,943	2,560,000	15,610	11,255,000	25,814
1969	1,535,000	21,319	3,400,000	30,357	1,870,000	21,250	2,011,000	12,262	8,816,000	20,220
1970	1,585,000	22,014	3,430,000	30,625	1,850,000	21,023	2,528,000	15,415	9,393,000	21,544
1971	920,000	12,777	6,470,000	57,768	1,310,000	14,886	2,580,000	15,732	11,280,000	25,872
1972	2,070,000	28,750	4,970,000	44,375	1,328,000	15,091	2,830,000	17,256	11,198,000	25,683
1973	2,080,000	28,889	2,500,000	22,321	1,325,000	15,057	2,194,000	13,378	8,099,000	18,576
Average	1,408,222	19,559	4,032,600	36,005	1,549,000	17,602	3,308,000	20,171	10,297,822	23,619

*Not censused

This level of use is approximately six times greater than the use of the reservoirs by geese. Duck use has been evenly distributed along the 436-mile chain of lakes, except for the greater than average use by ducks at Fort Randall Reservoir.

No quantitative mid-winter waterfowl-use statistics were presented in either the formal predictive FWS report of 1962, or the basic data support files. The 1962 report did contain the statement that wintering flocks were expected to be larger following impoundment of Lake Sharpe. The SDGFPD have conducted mid-winter aerial surveys of the reservoir chain each year since 1959. These mid-winter waterfowl inventories, for five years prior to inundation of Lake Sharpe and for eleven years after impoundment, do indicate larger wintering waterfowl flocks after construction of the reservoir (Table 6).

Information presented in SDGFPD Pittman-Robertson annual reports since 1967 (9,15-20) permitted calculation of waterfowl-harvest and hunting-pressure statistics for each South Dakota county. These statistics for the five counties bordering Lake Sharpe are presented in Table 7 for geese and in Table 8 for ducks. For the seven-year period of record (1967-1973), an average of 7,528 geese have been harvested in 14,507 hunter-days in these five counties. Not all of the waterfowl hunting and harvest in the five counties can be attributed to Lake Sharpe, however, as all but one of the counties bordering Lake Sharpe also border either Oahe Reservoir or Fort Randall Reservoir.

To correct for the waterfowl contribution of these other reservoirs, total county waterfowl-harvest and hunting-pressure statistics (reported in Tables 7 and 8) were reduced by the ratio of each county's total reservoir

Table 6.--SDGFPD mid-winter aerial counts of geese and ducks for reservoirs and reservoir related sections of Missouri River in South Dakota. Data presented is summarized separately for years prior to inundation of Lake Sharpe (1959-1963) and for years following Lake Sharpe inundation (1964-1974)

Date of flight	Gavins Point (Lewis and Clark Lake)		Fort Randall (Lake Frances Case)		Big Bend (Lake Sharpe)		Oahe		Total	
	No. geese	No. ducks	No. geese	No. ducks	No. geese	No. ducks	No. geese	No. ducks	No. geese	No. ducks
January 10, 1959	0	79,250	2,970	233,900	2,575	4,200	125	185,200	5,670	502,550
" 4, 1960	800	11,675	11,800	31,000	300	0	0	0	12,900	42,675
" 4, 1961	805	245,530	7,650	65,800	70	150	0	925	8,525	312,405
" 3, 1962	0	1,450	4,740	80,630	1,200	649	0	0	5,940	82,729
" 7, 1963	0	90,960	9,503	110,020	2,885	2,070	2,067	30,993	14,455	234,043
Average	321	85,773	7,333	104,270	1,406	1,414	438	43,424	9,498	234,881
January 6, 1964	331	*	10,074	144,100	6,855	18,400	0	3,293	17,260	*
" 4, 1965	104	59,793	2,721	1,605	0	35	0	3,850	2,825	65,283
" 3, 1966	201	74,692	12,210	52,100	9,329	19,200	1,015	10,880	22,755	156,872
" 9, 1967	0	17,890	6,410	13,335	1,455	23,650	1,016	2,208	8,881	57,083
" 8, 1968	540	72,135	4,660	7,700	82	8,300	0	0	5,282	87,135
" 6-7, 1969	100	1,225	0	915	365	1,035	228	2,850	693	6,025
" 9, 1970	25	150	0	0	2,500	550	0	2,850	2,525	3,550
" 5, 1971	*	*	*	*	15,000	8,703	0	0	*	*
" 3, 1972	0	46,362	900	25,300	**	**	**	**	900	71,662
" 8, 1973	950	1,900	228	1,264	1	2,700	0	0	1,179	5,864
" ?, 1974	1,500	65,100	7	4,450	70	2,906	0	3,994	1,577	76,450
Average	375	37,583	3,721	25,077	3,242	7,771	205	3,175	7,543	73,606

*No counts made.
**Lake frozen.

Table 7. -- Estimated numbers of goose hunter-days and geese harvested in the South Dakota counties bordering Lake Sharpe in the years 1967 through 1973

Years	COUNTIES											
	Buffalo		Hughes		Hyde		Stanley		Lyman		Total	
	No. geese killed	No. goose hunter-days	No. geese killed	No. goose hunter-days	No. geese killed	No. goose hunter-days	No. geese killed	No. goose hunter-days	No. geese killed	No. goose hunter-days	No. geese killed	No. goose hunter-days
1967	375	655	4,348	9,003	218	695	119	417	516	1,291	5,576	12,061
1968	199	770	4,395	7,051	174	894	74	521	1,465	4,966	6,307	14,202
1969	460	854	3,636	7,315	394	263	263	766	1,424	4,380	6,177	13,578
1970	46	69	2,954	6,331	0	161	321	665	1,832	4,129	5,153	11,355
1971	302	432	5,375	9,850	324	670	130	302	2,634	3,003	8,765	14,257
1972	206	360	5,215	9,732	231	822	231	385	1,824	3,929	7,707	15,228
1973	936	824	8,399	14,345	579	1,225	1,448	1,782	1,649	2,695	13,011	20,871
Average	361	566	4,903	9,090	274	676	369	691	1,621	3,485	7,528	14,507

Table 8. --Estimated numbers of duck hunter-days and ducks harvested in the South Dakota counties bordering Lake Sharpe during the years 1967 through 1973

Years	Buffalo		Hughes		Hyde		Stanley		Lyman		Total	
	No. ducks killed	No. duck hunter-days	No. ducks killed	No. duck hunter-days	No. ducks killed	No. duck hunter-days	No. ducks killed	No. duck hunter-days	No. ducks killed	No. duck hunter-days	No. ducks killed	No. duck hunter-days
1967	1,763	1,148	4,358	3,247	654	396	257	218	1,169	1,148	8,201	6,157
1968	1,490	895	2,234	2,784	348	199	943	920	1,986	2,088	7,001	6,886
1969	438	460	4,582	3,592	614	482	548	372	2,521	2,365	8,703	7,271
1970	1,306	733	4,398	2,907	733	435	298	183	1,603	984	8,338	5,242
1971	604	497	7,426	6,307	2,008	1,836	1,900	1,900	2,893	2,030	14,831	12,570
1972	1,927	1,104	12,589	6,318	3,854	2,029	2,030	642	7,322	4,340	27,772	14,433
1973	1,336	779	7,127	5,589	1,537	1,047	668	779	4,699	3,629	15,367	11,823
Average	1,266	802	6,102	4,392	1,393	918	949	716	3,170	2,369	12,880	9,197

shoreline to the portion composed of Lake Sharpe shoreline. For example, Lyman County borders both Lake Sharpe and Fort Randall Reservoir. Since approximately 45 percent of the county's reservoir shoreline is on Lake Sharpe, it was assumed that 45 percent of the Lyman County goose harvest and goose hunter-days could be associated with Lake Sharpe. The percentages used for Hughes, Stanley and Buffalo Counties were 80, 37, and 50 percent, respectively. Hyde County borders only Lake Sharpe and 100 percent of the harvest and pressure was attributed to Lake Sharpe. Table 9 presents these corrected seven-year average harvest and hunter-days data.

Contribution to the county wide harvest and hunting pressure by smaller water bodies within each respective county would also lessen the relative contribution of Lake Sharpe. SDGFPD personnel were asked about this factor, and they provided the following estimates in a personal communication (21):

> We believe that almost all of the goose hunting prior to the development of Lake Sharpe was attributable to the Missouri River as it is now attributable to Lake Sharpe in those counties bordering Lake Sharpe.
>
> * * *
>
> It is also my estimation that since the impoundment of Lake Sharpe that at least 75 percent of the duck harvest in that area is attributable to Lake Sharpe (birds which rest on Lake Sharpe).

Assuming that 100 percent of the corrected goose harvest and pressure data could be attributed to the reservoir, the estimated annual post-impoundment harvest of geese attributable to Lake Sharpe would be 5,243 birds taken during 10,055 hunter-days. Similarly, if 75 percent of the duck harvest and hunting pressure were associated directly with Lake Sharpe, the estimated harvest would be 6,515 birds harvested in 4,623 hunter-days annually.

Table 9.--Average Lake Sharpe-associated goose and duck harvest and hunting pressure statistics for the five counties bordering Lake Sharpe for the years 1967-1973

Counties	Geese		Ducks	
	No. killed	No. hunter-days	No. killed	No. hunter-days
Stanley	137	256	351	265
Lyman	729	1,568	1,427	1,066
Buffalo	181	283	633	401
Hughes	3,922	7,272	4,882	3,514
Hyde	274	676	1,393	918
Total	5,243	10,055	8,686	6,164

Waterfowl Resources -- Evaluation of Planning Input

No lands were purchased by the development agency specifically for wildlife mitigation purposes. Acquisition and development of the 2,960-acre tract, which was recommended by the FWS for administration as a State wildlife management area, was not viewed favorably by the CE because of the State's position on land acquisition. The SDGFPD Commission's resolution, adopting a position that lands required for fish and wildlife purposes should not be acquired by condemnation proceedings from unwilling sellers, was considered an untenable restriction on land acquisition by the CE. The FWS indicated that every effort should be made to acquire the property by amicable agreement and that the Government should use condemnation only as a last resort but that the Government could not forego exercise of its right of eminent domain. It was the FWS position that the land acquisition question should be submitted to Congress for consideration (22). However, on December 22, 1964, the Office, Chief of Engineers, Washington, D.C., ordained (12) that:

> Further processing of the subject report for modification of the project (Big Bend Dam and Lake Sharpe Project) will be contingent upon the South Dakota Commission withdrawing the Commission Resolution relative to the acquisition of land in South Dakota for wildlife purposes as the basis for their approval and recommendation of the proposed plan of acquisition.

Waterfowl were considered the most important wildlife using the Lake Sharpe project site and project construction was expected to significantly affect distribution of the fall and winter use of the area by migratory waterfowl.

Evaluation of the planning process, in terms of relative success of predicting the direction and magnitude of the changes which have occurred in goose-day use of the project area, is influenced by the set of

pre-impoundment data selected for the base reference point. According to the pre-impoundment use estimates of the FWS (Table 1), an average of 1,561,475 goose-days were recorded annually (1953-1959) on the four reservoir sites on the Missouri River. State estimates of annual goose use on the same area, though for a later pre-impoundment period (1959-1963), totaled only 872,350 goose-days (Table 2). The State's goose-day use estimates for the post-impoundment period was 1,588,028 (Table 4). Table 10 summarizes the various goose-day use projections, and comparisons with the SDGFPD estimates of goose-day use of the four reservoirs since construction of Lake Sharpe.

The FWS expected no overall change in intensity of goose use, merely a redistribution of the existing use. Based on their pre-impoundment estimates, this expectation appears to have been accurate. According to the State pre-impoundment data, however, total use of the Missouri River reservoirs in South Dakota has increased significantly (+82 percent) in the years following Lake Sharpe impoundment.

Goose use of Lake Sharpe, itself, was projected by the FWS to average approximately 280,000 goose-days during the migratory season. State data indicates the actual use during the migratory season has averaged 480,000 goose-days since impoundment of Lake Sharpe in 1964. Thus, State data appear to indicate that goose use of Lake Sharpe has been approximately 71 percent greater than was anticipated by the FWS.

Based upon the FWS's pre-impoundment estimates, Gavins Point (Lewis & Clark Lake) and Fort Randall (Lake Francis Case) have received less use by geese since construction of Lake Sharpe. According to the State's pre-impoundment use estimates, however, all of the reservoirs have experienced greater

Table 10.--Estimated goose-day use of Missouri River main stem impoundments in South Dakota as estimated by FWS and SDGFPD personnel for periods of years before and after construction of Lake Sharpe

Impoundment	Pre-impoundment goose-day annual use estimates		Post-impoundment goose-day annual use estimates	% Increase (+) or decrease (-)	
	By FWS	By SDGFPD	By SDGFPD	From FWS-Pre	From SDGFPD-Pre
Gavins Point (Lewis & Clark Lake)	63,390[1]	5,986[2]	7,300[4]	-88.5	+22.0
Fort Randall (Lake Francis Case)	1,181,042[1]	593,561[2]	749,035[4]	-36.6	+26.2
Big Bend (Lake Sharpe)	177,226[1]	150,813[3]	479,861[4]	+170.8	+218.2
Oahe	139,817[1]	121,990[3]	351,832[4]	+151.6	+188.4
Total	1,561,475	872,350	1,588,028	+1.7	+82.0

[1] Period of record - 1953-1959

[2] Period of record - 1959-1963.

[3] Period of record - 1962-1963.

[4] Period of record - 1964-1973.

waterfowl use since Lake Sharpe was impounded.

Average use of the entire chain of reservoirs by ducks during the 10-year period following impoundment has been approximately 73 percent greater than the average duck-day use during the 9-year period immediately preceding Lake Sharpe inundation. Only a slight increase in duck use was specifically forecast for Lake Sharpe by the FWS. Actually, post-impoundment data indicate that 15.5-fold increase occurred at the Lake Sharpe site following reservoir completion (Tables 3 and 5).

Use of the project area by wintering waterfowl was expected to be greater after construction of Lake Sharpe. Although highly variable from year to year, the aerial counts indicate that mid-winter waterfowl use of the Lake Sharpe site has, indeed, increased since reservoir construction. The increased use of Lake Sharpe, combined with an overall reduction in the use as wintering grounds of the other main-stem impoundments, resulted in a great increase in the relative importance of Lake Sharpe as a wintering area in relation to the remainder of the system. Wintering use of the Lake Sharpe site by geese increased by 130 percent over pre-impoundment use, with 43 percent of the geese that overwinter on the Missouri River in South Dakota making use of Lake Sharpe. There was negligible duck wintering use of the Lake Sharpe site prior to impoundment. Aerial winter counts indicate that 10 percent of the main-stem, winter duck-use now occurs on Lake Sharpe.

Conflicting figures appear in the two sections of the 1962 FWS predictive report regarding goose hunting projections. The letter-report indicated a pre-impoundment hunting pressure figure of 3,300 goose hunter-days and a projected increase of 2,600 goose hunter-days following project construction.

Total estimated post-impoundment goose hunting would thus have been 5,900 hunter-days. In the substantiating section of the 1962 FWS report, reservoir construction is projected as providing an additional 5,900 hunter-days for geese. The basic data files clearly indicate that only 2,600 additional hunter-days were actually expected.

Available hunting-pressure data indicate that post-impoundment goose hunting pressure associated with Lake Sharpe has averaged 10,055 hunter-days annually since 1967. This is approximately 82 percent higher than the level projected by the FWS. Hunting success has apparently been much greater than was expected in the predictive report, as the annual post-impoundment harvest of 5,243 birds attributable to Lake Sharpe, is 3.7 times greater than predicted.

Some 700 duck hunter-days were estimated to occur annually on the Missouri River within the Lake Sharpe site prior to project construction. It was estimated that annual harvests of about 2,000 ducks resulted from this effort. No significant change in use of the project area was envisioned after project completion. According to the estimates developed during this analysis, 4,623 duck hunter-days and a harvest of 6,515 birds can be attributed to Lake Sharpe. Obviously, if the pre-impoundment data accurately reflected the extent of the duck hunting pressure, a very significant increase in duck hunting activity has occurred since construction of Lake Sharpe.

Waterfowl use of Lake Sharpe, together with hunting pressure and harvest have exceeded the levels predicted by the FWS. This higher than expected utilization has occurred even though the waterfowl management area recommended by the FWS was never developed. It should be noted, however, as

the FWS pointed out in their predictive report, the increase in waterfowl use at Lake Sharpe was the result of birds being attracted from other established migratory routes within the Central Flyway.

Big Game Resources -- Pre-impoundment Predictions

Wildlife resources of the Lake Sharpe project area were described in qualitative terms in the letter-report section of the 1962 FWS pre-impoundment planning document. The pertinent sections dealing with big game resources were as follows:

> The Big Bend Reservoir area provides excellent habitat for many species of game and non-game animals. Both white-tailed and mule deer are found in the river bottoms, and a few antelope range in the uplands along the reservoirs.
>
> About two-thirds of the reservoir area is within the boundaries of the Lower Brule and Crow Creek Indian Reservations. Low populations of wildlife are characteristic of the area at the present time. This fact, and the inaccessibility of much of the area, results in relatively low hunter use.

The more comprehensive substantiating report elaborated on the pre-impoundment big game resources and provided some quantitative harvest and hunting pressure statistics; viz:

> White-tails are the most numerous, although the proportion of mule deer appears to be increasing. There is little deer habitat on either side of the proposed reservoir for many miles. There have been deer hunting seasons in the area during 7 of the last 10 years. In 3 years of the 7 there was also a bow-hunting season. The South Dakota Department of Game, Fish and Parks estimates that approximately 100 deer are harvested annually from the area, less than 10 percent of which are killed by bow hunters. About 460 big-game hunter-days, of which about 200 are by bow hunters, are expended in the area each year.

In the section of the 1962 letter-report describing the expected impact of the Lake Sharpe project on game, the only comments relating to big game were:

> Big game, upland game, and fur animals will suffer loss of about 55,000 acres of habitat due to inundation by the reservoir.

There was also a brief statement summarizing the anticipated impact of reservoir construction on all wildlife habitat types, including big game; viz:

> Wildlife habitat, with the exception of waterfowl habitat will suffer substantial losses. These losses will exceed the gains anticipated from improved conditions for waterfowl and waterfowl hunting.

The resultant loss of big game habitat was addressed in more detail in the substantiating report, including the following discussion of vegetative succession around the perimeter of the new reservoir:

> All terrestrial wildlife habitat below elevation 1,420 will be lost by flooding. This includes approximately 11,900 acres of trees and brush, 23,200 acres of river and sandbars, 5,400 acres of cultivated land, and 15,300 acres of grasslands. In addition, a relatively small acreage will be lost by wave action and bank erosion. Only a small amount of littoral vegetation is expected to become established around the reservoir, because of steep slopes and because of the frequency and rapidity of water level fluctuation, even though the magnitude of this fluctuation will not be great. However, some willow and other woody vegetation may become established on relatively level shores near the upper reaches of the reservoir. It is also possible that some limited marsh vegetation may develop where shallow water will be protected from winds and wave action.
>
> Since woody cover in this vicinity is almost entirely confined to the river bottom, the loss of this type of cover will be particularly severe. Most of the cover on which the deer population of the area is dependent will be destroyed by flooding. Since the uplands surrounding the reservoir contain little natural cover of the type preferred by deer, and practically no planted cover, only remnant populations of big game are expected to remain in the vicinity. Loss of deer hunting is expected to be complete.

Big Game Resources -- Post-impoundment Occurrences

No deer harvest or hunting pressure information relating directly to the Lake Sharpe project lands are available. For purposes of this study,

SDGFPD personnel were asked to estimate the relative importance of project associated lands to the area's big game resources. Unfortunately, they were not able to do so (21). The SDGFPD collects and reports game hunting statistics by individual counties; and in order to evaluate the project's impact on big game resources, the investigative staff had to rely on these county records. The counties of South Dakota are divided into three distinct units for purposes of deer herd management, viz: (1) East River prairie counties, (2) West River prairie counties, and (3) Black Hills. The two groups of prairie counties are divided by the Missouri River. As a result, post-impoundment effort and harvest data for the counties (Hughes, Hyde, Buffalo on the east; Stanley and Lyman on the west) impacted by Lake Sharpe were reported in separate series of Pittman-Robertson reports. Deer harvest and license sales information was used to compile hunting statistics for Hughes, Hyde, and Buffalo Counties. This information was contained in Pittman-Robertson reports covering the East River prairie counties (23-25). Annual hunting statistics for these three counties for the period 1959 to 1973 (includes 5 pre-impoundment and 10 post-impoundment seasons) are presented in Table 11. These data show that the average annual deer kill for the 5 pre-impoundment years was 55 animals and the average success rate was 0.60 deer killed/license sold. Sixty-three deer were killed in 1964, which was the first year after impoundment, and the success rate was 0.79 deer killed/license sold. The average figures for the 10 year period of post-impoundment record were 172 deer harvested/year and 0.67 deer harvested/license sold.

The year that Lake Sharpe was impounded (1964), deer herd management strategy for the West River prairie counties (including project-impacted

Table 11.--Deer harvest, license sales and hunter success rates for the three East River prairie counties bordering Lake Sharpe, South Dakota for a period before (1959-1963) and after (1964-1973) impoundment

Year	Number of deer killed	Number of licenses sold	Number of deer killed/ licenses sold	Number of bucks killed/ licenses sold
Pre-impoundment				
1959	113	192	0.59	0.41
1960	44	65	0.68	0.43
1961	34	63	0.54	0.40
1962	39	65	0.60	0.38
1963	43	68	0.63	0.56
Average	55	91	0.60	0.43
Post-impoundment				
1964	63	80	0.79	0.60
1965	87	118	0.74	0.58
1966	134	188	0.71	0.44
1967	156	240	0.65	0.52
1968	162	222	0.73	0.55
1969	207	366	0.57	0.41
1970	221	360	0.61	0.47
1971	202	300	0.67	0.51
1972	239	321	0.74	0.58
1973	249	350	0.71	0.55
Average	172	255	0.67	0.51

Stanley and Lyman Counties) was dramatically altered. The number of deer licenses issued in each county was unlimited prior to 1964. No county records of the number of licenses issued were maintained during this early period. In 1964, an established quota of licenses was issued for each county. Table 12 summarizes the available deer harvest and license sales data for Stanley and Lyman Counties that were provided by SDGFPD personnel and documents (24-32).

The average annual pre-impoundment deer harvest (374 animals) from the two affected West prairie counties was much greater than the harvest from the three bordering East River prairie counties. The number of licenses sold for the two bordering West River counties was 150 in 1964, with a resultant harvest of 131 deer. Harvest and license sales have generally increased since lake impoundment.

Big Game Resources -- Evaluation of Planning Input

The deer population in the Lake Sharpe project area was not large. The FWS reported an annual pre-impoundment harvest of 100 animals. According to the pre-impoundment report, the deer population in the project area was supported by Missouri River bottom land habitat, and little cover existed for several miles on either side of the reservoir site. As a result, the FWS predicted a total loss of deer hunting in the vicinity of the project after Lake Sharpe was filled. No planning recommendations were developed by the FWS to mitigate the big game losses expected to occur as a result of project construction. The 1962 FWS letter-report merely stated: "Losses sustained by deer cannot feasibly be mitigated."

Table 12.--Number of deer killed, big game licenses sold, and success rates for two West River prairie counties bordering Lake Sharpe, before (1962-1963) and after (1964-1973) impoundment

Year	Number of deer killed	Number of licenses sold	Number of deer killed/ licenses sold	Number of bucks killed/ licenses sold
Pre-impoundment				
1962	303	**	**	**
1963	445	**	**	**
Average	374	**	**	**
Post-impoundment				
1964	131	150	0.87	0.87
1965	289	350	0.83	0.83
1966	414	500	0.83	0.64
1967	561	700	0.80	0.58
1968	648	794	0.82	0.59
1969	713	923	0.77	0.51
1970	574	767	0.75	0.64
1971	582	834	0.70	0.62
1972	690	884	0.78	0.63
1973	799	967	0.83	0.66
Average	540	687	0.79	0.62

**Unlimited; data not available by counties.

According to SDGFPD statistics (Tables 11 & 12), the average deer harvest from the five South Dakota counties (Hughes, Hyde, Buffalo, Stanley, and Lyman) bordering the project area was 429 animals prior to project completion. The deer harvest (100 animals) on the immediate project area would, therefore, have constituted approximately 23 percent of the five county total. A loss of this magnitude should have been reflected in the harvest data for the affected counties during subsequent post-impoundment seasons.

To permit a more detailed evaluation of the expected loss, the FWS pre-impoundment harvest estimate for the immediate project area (100 animals) was divided among the five impacted counties. This was accomplished by assuming that the area flooded in each of the five affected counties was proportional to the length of pre-impoundment river frontage, and that the deer population and harvest were uniformly distributed within the river bottom habitat. Table 13 presents the resulting pre-impoundment harvest estimate by counties based on such apportionment. This apportionment suggests that perhaps one-half (50 animals) of the reported pre-impoundment deer harvest occurred within the three East River prairie counties.

SDGFPD records (Table 11) show that an average of only 55 deer were harvested annually from the three East River prairie counties during the years prior to reservoir impoundment (1959-1963). It seems probable, therefore, that if the Missouri River bottom land habitat of the three East River prairie counties was indeed critical and irreplaceable (as indicated in the pre-impoundment report), reservoir construction should have caused a noticeable decline in the number of deer killed in those three counties. However, the post-impoundment statistics for the three

Table 13.--Assumed county distribution of the pre-impoundment deer harvest (100 deer) estimated by FWS for the Lake Sharpe project area

West River prairie counties	Number deer harvested	East River prairie counties	Number deer harvested
Stanley	20	Buffalo	7
Lyman	30	Hughes	40
		Hyde	3
Total	50	Total	50

East River prairie counties did not reflect any reduction in the number of animals harvested (Table 11). The first year after inundation of Lake Sharpe (1964), 63 deer were harvested and the hunter success rate of 0.79 deer killed/license sold was higher than any of the five pre-impoundment years of record. Also, the success rate for bucks was better in the years after Lake Sharpe was impounded. This suggests that the deer herd was expanding, and that the improved hunting could not be attributed to an increased harvest of antlerless deer alone.

A corresponding pre-impoundment/post-impoundment evaluation of the two West River prairie county deer harvest records was not possible because a major change in deer management strategy occurred simultaneously with impoundment. Also, the pre-impoundment harvest of some 50 animals associated with the reservoir project lands located in the two impacted West River prairie counties (which would have constituted only 13 percent of the total pre-impoundment deer harvest of 374 animals) would have been difficult to isolate. It merely may be noted that deer harvest from Stanley and Lyman Counties increased steadily after impoundment in 1964, as have the number of big game licenses issued.

It will be recalled that the FWS report stated that: "There is little deer habitat on either side of the proposed reservoir for many miles." The report further stated: "Since the uplands surrounding the reservoir contain little natural cover of the type preferred by deer, and practically no planted cover, only remnant populations of big game are expected to remain in the vicinity. Loss of deer hunting is expected to be complete."

It was not possible to evaluate the adequacy of these FWS predictions because of the lack of concrete data dealing specifically with the immediate

project area. Obviously deer were eliminated in the immediate reservoir area. However, examination of pre- and post-construction deer kill data collected annually by the SDGFPD from counties contiguous to the project indicated a continuing increase in both hunter success rates and total harvest following project construction. This fact suggests that the impact of the project had little or no significant adverse influence on deer in the surrounding counties. Either the project area was not supporting a deer harvest of the magnitude described in the FWS report or, contrary to the FWS, adequate habitat was available outside the reservoir site to accommodate an expanding deer herd and the steadily increasing hunting pressure.

Upland Game Resources -- Pre-impoundment Predictions

The 1962 FWS pre-impoundment planning report described the upland game resources only in qualitative terms, viz:

> The Big Bend Reservoir area provides excellent habitat for many species of game and non-game animals. Pheasants, sharp-tailed grouse, and cottontails are the most important of the upland-game species.

The substantiating section discussed the upland game pre-project resources in more detail, and provided quantitative predictions, viz:

> It is estimated that about 1,000 pheasants are killed in the reservoir area in 440 hunter-days annually, but much higher populations winter in the area.
>
> The reservoir is also more important to sharp-tailed grouse than kill figures would indicate because the Missouri River bottomlands contain some of the best winter food and cover found in this large section of the State. While an estimated 100 grouse are killed in the area in about 50 hunter days annually, the river bottoms are particularly important as winter habitat for many birds from surrounding lands.
>
> Prairie chickens are found in the upland to the southeast of the river and use the bottomlands only during the winter. Hungarian partridges also are seen in the area occasionally,

but furnish little hunting. Cottontails are numerous in the bottomland cover but are not hunted intensively. Interest in the cottontail as a game species seems, however, to be increasing. Fox squirrels are scattered throughout the bottomland timber but do not furnish much hunting.

While the number of man-days expended in hunting has been somewhat low, the trend is toward heavier use each year. It is estimated that an average of 750 man-days a year are expended hunting Hungarian partridge, cottontails and fox squirrels in the Big Bend Reservoir area. An estimated 1,500 of the three species (mostly cottontails) are killed annually.

Mourning doves are not legal game in South Dakota, but the State produces large numbers which are hunted further south. An estimated 7,000 young doves are produced annually in the timberland river bottoms of the Big Bend site.

Fur-bearers in the reservoir area included jackrabbits, striped skunks, raccoons, beavers, red foxes, minks, weasels, muskrats, and badgers. Treatment of the use and value of this resource was of a general nature, with no quantitative values provided.

The projected impact of Lake Sharpe construction on upland game and fur animals was presented in a single sentence in the 1962 FWS letter-report to the CE:

> Big game, upland game, and fur animals will suffer loss of about 55,000 acres of habitat due to inundation by the reservoir.

This slightly more detailed summary of the reservoir's expected impact on the upland game and fur animal resources was provided in the substantiating section of the 1962 FWS report:

> All upland game habitat in the reservoir area below the 1,420 feet contour will be lost. This includes an area contributing 1,240 hunter-days annually, as well as the production of an estimated 7,000 mourning doves annually. It includes, in addition, habitat which is used quite extensively during the winter by sharptailed grouse and prairie chicken populations.
>
> There also will be a substantial loss of fur animals, since all terrestrial habitat and most of the habitat for aquatic and semi-aquatic fur animals will be lost below the 1,420 contour. Small numbers of minks, raccoons, and beaver will remain, but no muskrats are expected to survive in the reservoir area.

The quantitative estimates contained in the 1962 report were generated by the FWS in cooperation with biologists from the SDGFPD (8). To calculate estimates of the potential recreational loss associated with pheasant and grouse populations, the FWS computed average harvest values per square mile for each impacted county using the State's survey data. The square-mile-unit statistics were then multiplied by the number of square miles to be inundated in each of the five counties. Computed harvests in the reservoir area were then divided by average hunter success values for each county to calculate hunting activity (number of hunter-days).

These calculations indicated a potential reduction in harvest of 489 pheasants and the loss of 293 pheasant hunter-days per year as a result of reservoir construction. Upon review of the FWS developed data, SDGFPD personnel, apparently believing the bottom-land habitat to be of greater value to pheasants than the upland habitat of the five counties, increased the pre-impoundment estimate to 1,000 pheasants harvested during 440 hunter-days. These later statistics were the ones employed in the FWS report to the CE.

Grouse data were calculated by the FWS in a similar fashion (average kill per square mile x number of square miles inundated). The computations indicated that 74 grouse were killed in 47 man-days of hunting. These values were apparently rounded-off, either during State review or by the FWS, to the ratio utilized in the 1962 report, namely 100 grouse killed in 50 man-days.

Fox squirrels and cottontail rabbit harvests computed by the FWS were based upon "educated guesses" of standing crops and percent kill. For

cottontails, a guessed density of 100 per section was multiplied by the number of sections of woody cover in the proposed reservoir site (18.59) to provide an estimated standing crop of 1,859 rabbits. A 20 percent harvest rate was used, providing an estimated harvest of 372 cottontails. Similarly, a standing crop of 20 fox squirrels per section, multiplied by a 20 percent harvest rate, provided an estimated annual harvest of 74 fox squirrels. These estimates were combined with the Hungarian partridge harvest ("kill small, if any, in the reservoir area") and increased, probably upon State review, to provide the estimated annual harvest of 1,500 upland game units used in the report.

Mourning dove production was estimated by multiplying a nesting density factor developed by the Missouri River Study Unit (1 pair per 6.67 acres of woody cover), times another factor for young per breeding pair (3.98), times the number of acres of woody habitat in the proposed reservoir basin. These calculations resulted in an estimated production of 7,000 doves.

Upland Game Resources -- Post-impoundment Occurrences

SDGFPD personnel have conducted small-game-hunter postal surveys each year to obtain statewide indicies of harvest and hunting pressure for pheasants, grouse, and Hungarian partridge. The questionnaires asked hunters to indicate the number of days hunted, the number of birds bagged, and the county in which most of the hunting was done.

As reported in the big game section, SDGFPD personnel were unable to provide any relative percentage values for hunter use of project lands apart from the remainder of the affected counties (21). It was, therefore, necessary to rely on the county data even though Lake Sharpe inundated

only 1.7 percent of the total land area in the five counties involved. The bottomlands of the Missouri River were described as prime habitat and as being more important per acre than the surrounding habitat with respect to the upland game resources.

Loss of this high-value, bottom-land wintering cover could have been of sufficient magnitude to be reflected in the county-wide harvest statistics. Table 14 summarizes the pheasant and grouse hunting and harvest information for the five counties containing Lake Sharpe lands, as well as for the entire State for a four-year period prior to impoundment and a ten-year period following impoundment. The table summarizes information obtained from several SDGFPD reports (33-47).

While the pheasant population in all areas (as reflected by harvest and hunter success) has declined, the decline experienced in the five counties, directly impacted by Lake Sharpe has been less than for the entire State (Table 14). Hunting pressure for pheasants actually increased in the counties bordering Lake Sharpe while declining by some 20 percent over the State as a whole. The grouse data reflect increasing populations, judging from the numbers harvested, but the increase has been less in the five target counties than in the State as a whole.

The State's upland game postal surveys have not attempted to identify the relative importance of such upland game species as cottontail rabbits or fox squirrels. Also, no data are available relating to mourning dove reproduction.

Table 14. --Average annual pre-impoundment and post impoundment hunting pressure and harvest for pheasants and grouse in those counties losing land to Lake Sharpe and for all of South Dakota

	Pheasant			Grouse		
	Number of hunters	Total harvest	Birds/ hunter	Number of hunters	Total harvest	Birds/ hunter
Five impacted counties:						
Pre-impoundment (1960-1963)	2,786	30,931	11.1	1,828	8,136	4.5
Post-impoundment (1964-1973)	2,977	15,930	5.4	3,119	13,347	4.3
Percent change	+6.9	-48.5	-51.4	+70.6	+64.0	-4.4
South Dakota						
Pre-impoundment (1960-1963)	138,238	2,190,250	15.8	11,113	49,300	4.4
Post-impoundment (1964-1973)	110,227	740,250	6.7	19,099	88,905	4.7
Percent change	-20.3	-66.2	-57.6	+71.9	+80.3	+6.8

Upland Game Resources -- Evaluation of Planning Input

The Lake Sharpe conservation pool flooded 55,800 acres of river bottom habitat. Prior to impoundment, 10 percent of the bottomland was under cultivation, approximately 50 percent was wooded or range land, and the remaining 40 percent was water and sandbars (3). Inundation of this habitat was expected to result in the loss of 1,240 man-days of upland game hunting and a harvest reduction amounting to 2,600 upland game animals including pheasants, sharp-tailed grouse, Hungarian partridge, cottontails, and fox squirrels. The pre-impoundment FWS report emphasized that the bottomland habitat supported much higher populations of pheasants, sharp-tailed grouse, and prairie chickens during the critical winter period.

The post-construction loss in man-days of hunting and harvest of upland game predicted by the FWS report must be taken at face value since this prediction obviously related solely to the area to be inundated by the project. Although mention was made of the importance of the bottomland as winter habitat for upland game species, the report failed to quantify any incremental losses in hunting opportunity and harvest in peripheral areas attributable to the elimination of winter habitat as a result of project construction. This oversight resulted in a probable under-estimation of the cumulative impact of the project on upland game resources.

Subsequent evaluation of the project's actual impact on upland game (as with other wildlife resources) was handicapped severely by the failure of the authors of the report to properly circumscribe the area of project impact, and by the concurrent lack of site specific pre- and post-construction hunter utilization and harvest data.

The only information available which could have been expected to reflect long-term upland game community changes within the project area were the harvest and hunting pressure statistics gathered by the SDGFPD for each county. Although the inundated acreage comprised only 1.7 percent of the total area of the five impacted South Dakota counties, this bottomland habitat was characterized as an important wintering area for many pheasants and sharp-tailed grouse from surrounding lands. Therefore, if loss of 4,816 ha (11,900 ac) of trees and brush were critical to the winter survival of a large number of birds and/or the loss of 6,192 ha (15,300 ac) of grassland nesting cover was of sufficient importance, such losses conceivably would have been reflected in the subsequent harvest statistics for the total five-county area.

Examination of pheasant resource trends showed that hunting pressure increased in the bordering counties while declining by some 20 percent statewide. Pheasant harvest, however, declined dramatically statewide between the pre-construction and post-construction periods, although the decline in the bordering five counties was not as severe as in the State as a whole. On the other hand, the harvest and hunting pressure for grouse in the five counties abutting Lake Sharpe, while increasing significantly, did not match the average increases which occurred over the entire State.

A number of land-use changes and other factors, particularly the curtailment of the Soil Bank Program, on over three million acres of land in the five-county area were probably more influential than the construction of Lake Sharpe. The collective effect of broad changes in land-use, coupled with the absence of site specific data, made it impossible to isolate the impact of Lake Sharpe on the upland game resources with the available data.

FISHERY RESULTS AND DISCUSSION

Fishery Resources -- Pre-impoundment Predictions

Fishery resources associated with the Lake Sharpe project area prior to project construction were described in the 1962 FWS report (3). The letter-report described the pre-impoundment Missouri River fishery as follows:

> The Missouri River within the area to be inundated by Big Bend Reservoir is a large stream well populated by a variety of fish. It does not, however, attract many fishermen except in the vicinity of Pierre and Fort Pierre. Human population in the vicinity is low and the tailwaters of Oahe Reservoir, a few miles above Pierre, attract most of the fishermen from that vicinity, though Oahe Reservoir itself is rapidly becoming established as a popular fishing area. Fort Randall Reservoir located just below the Big Bend Dam site attracts many fishermen from the lower reaches of the area.

The substantiating section of the 1962 report related that the fish community in the Missouri River, within the Lake Sharpe site, was changing from one dominated by non-game fish to one dominated by game and panfish. Several sport fish harvest statistics that were quoted, aeribed to a SDGFPD creel survey taken in the Oahe tailwaters, are as follows:

> According to a creel census taken between April 1961 and March 1962, the five species making up the highest percent of the creel numbers were: sauger (45%), channel catfish (20%), northern pike (14%), walleye (5%), and yellow perch and paddlefish (4%), while rough fish such as carp, red horse, carpsucker, gar, buffalo-fish, gizzard shad, and goldeye made up less than 11% of the catch. Fishermen caught over 128,000 fish in Oahe tailwaters.

The 1962 report did not contain quantitative use estimates, either in monetary or man-day terms, for the pre-construction river fishery. It was in a 1962 interoffice memo (48), that the Area Supervisor provided the Regional Supervisor with estimates of fishing use. The pre-impoundment

angler use of the Missouri River within the Lake Sharpe site was estimated to be 11,000 angler-trips per year having an assigned value of 50¢ per trip. The monetary value assigned was from the Report of the Panel on Recreational Aspects of Fish and Wildlife (49). No direct statement identified the exact area covered by the pre-impoundment figures.

Expected post-impoundment fishery conditions following construction of Lake Sharpe were described as follows in the letter-report:

> Big Bend Reservoir will be beneficial to fish resources of the area. Temperature conditions expected in the reservoir will favor a trout fishery over warm-water species. However, there is no absolute assurance that the water temperature will be low enough to support trout and exclude most of the warm-water species. A trout fishery may be slow in developing due to the competition from residual populations of warm-water fish that are present at the time of impoundment. However, since conditions will favor trout it is believed that they eventually will become established. A trout fishery in Big Bend Reservoir will compare favorably with warm-water fisheries found in the general vicinity, and it is estimated that about 111,000 fishermen days will be expended annually at the reservoir.
>
> * * *
>
> In summary, fisheries resources will benefit from development of Big Bend Reservoir. The net annual increase in fishing value, based on an evaluation of expected utilization by fishermen, is estimated at $105,000.

More detailed and specific post-impoundment sport fishery predictions were contained in the substantiating section, viz:

> Non-game fish species such as the carp will find conditions in the Big Bend Reservoir less favorable than in the pre-impoundment stream.
>
> * * *
>
> For several years there has been good fishing for paddlefish in the tailwater of Fort Randall Reservoir, but in late 1960 there was a noticeable drop in the success of those snagging paddlefish. Earlier publications, as well as some recent research papers, express concern that dams on streams may

exclude this fish from its most productive spawning grounds, resulting in a severe reduction in total numbers.

* * *

Rainbow trout have been taken in several of the main stem reservoirs on the Missouri River but have never constituted an appreciable percent of the fish creeled. Unsuccessful plants of trout have been made twice since 1956 in the tailwaters of Fort Randall and Gavins Point Dams. However, conditions are expected to be more favorable for trout in the tailwaters of Oahe Dam and Big Bend Reservoir. Such low temperatures through most of the growing season results in slowgrowth for warm-water species. The result will be slow-growing fish of low demand if reliance is placed on warm-water fish. Any warm-water fishery in this location would receive greatly restricted fishermen use because of the proximity of Oahe Reservoir immediately upstream and Fort Randall immediately downstream, where there is good fishing for northern pike, sauger, paddlefish, and catfish. If a cold-water fishery can be established, it will be very popular since there is no trout fishery near. Since habitat conditions are expected to favor trout, it is believed that a trout fishery can be established and maintained through a stocking program.

The fishery basic data files (50) show that the use projections presented by the FWS in the 1962 report were developed by multiplying the human population within specified circles of influence (assumed 25-mile radius and 75-mile radius for pre-impoundment warm-water river fishery and post-impoundment reservoir trout fishery, respectively) by the percent of the population within the affected counties (counties touched by respective circles) which bought fishing licenses. These figures were then expanded to account for the 1 in 5 unlicensed anglers. The total number of anglers was then multiplied by the estimated number of annual fishing trips (5 per year for residents, 2 per year for non-residents) to develop total angler-trip estimates.

The computational equation can be presented as:

No. license holders (LH) = $\pi R^2 x D x P$

where: R = radius of selected circle of influence
D = population density of counties touched by selected circle
P = percent of population within same counties with fishing licenses

Total number of anglers (A) = $\frac{LH}{.80}$ (assumes 1 in 5 anglers were non-licensed)

Total number of angler trips = A x selected number of trips per year

Fishery-related developments, expected following Lake Sharpe construction, were discussed at somewhat greater length in the substantiating report. Reservoir populations of non-game species such as carp, were expected to be depressed by the low water temperatures and general reservoir conditions. Concern was expressed that more dams could exclude paddlefish from their most productive spawning grounds and result in severe reductions in abundance. The future fishery for this species was believed to be jeopardized. Cool waters released from the Oahe were expected to create habitat conditions suitable for a cold-water fishery in Lake Sharpe. In fact, it was expected that slow-growing fish of low demand would result if reliance were placed on warm-water fish. Any warm-water fishery in Big Bend was expected to receive "greatly restricted fishermen use" due to competition from the northern pike, sauger, paddlefish, and catfish fisheries of Oahe and Fort Randall Reservoirs. Since habitat conditions were expected to favor trout, the FWS anticipated that it would be possible to establish and maintain a trout fishery through a stocking program.

Fishery Resources -- Post-impoundment Occurrences

Investigations into the feasibility of providing a trout fishery at Lake Sharpe began immediately after impoundment. From June through early

September, 1964, a water temperature and water chemistry reconnaissance was conducted by the SDGFPD to evaluate the potential for stocking rainbow trout into Lake Sharpe (51).

The investigation revealed high levels of free carbon dioxide in late summer (13-20 ppm); these were considered cause for some concern in relation to trout survival. Other findings of this early study indicated that warm surface water was drawn through the Oahe power-intake openings, when 35 feet of water, or less, covered the structure, and passed into the Oahe tailwaters and then into Lake Sharpe. With progressive warming of Lake Sharpe, large areas of the reservoir were considered to have become unsuitable as trout habitat. The study concluded that it would be desirable to maintain more than 35 feet of water over the Oahe intake openings if trout were to receive serious consideration in the future.

Actually, three and one-third million trout were stocked in Lake Sharpe and the Oahe tailwaters between March 5 and June 5, 1964. Many problems were associated with these introductions, including high turbidity, low water-flow, higher-than-expected water temperatures (51), and depredations by fish and fowl (52).

At the same time the trout were being stocked (1964), both walleyes and northern pike produced large year-classes in Lake Sharpe. Northern pike dominated the game fish community through 1966, and walleyes increased in abundance to the point of becoming dominant in 1967 (53). A new feasibility study of possible introductions of coldwater fish was conducted between 1967 and 1968 (2). This investigation obtained information relating to reservoir water temperatures, dissolved oxygen, available food, water

flow, bottom types, and competitor species. Although summer water temperatures were discovered to be slightly above optimum, large areas of the Oahe tailwaters and the hypolimnetic waters of Lake Sharpe were found to have temperatures suitable for the more temperature tolerant salmonid species. No oxygen deficiency was discovered. The study concluded that competition and predation by other species rendered trout stocking in Lake Sharpe infeasible, although suitable trout habitat was available, and recommended against stocking salmonid fish. To date, no further effort has been made to establish a trout fishery in the waters of Lake Sharpe.

A post-impoundment creel survey of Lake Sharpe was conducted from mid-May, 1973, through May, 1974, by a graduate student at South Dakota State University (54). The creel survey combined aerial counts with an angler-interview survey, designed to estimate fishing pressure and catch rates. Harvest was calculated as a product of the other two statistics. The creel survey obtained 95% confidence intervals of $\pm$9.60% and $\pm$12.45% for estimates of annual fishing pressure and harvest respectively. For purposes of the survey, Lake Sharpe was divided into three zones: (1) Oahe tailrace, extending into Lake Sharpe headwaters 9.6 km (6.0 mi), encompassing 571 ha (1,430 ac); (2) Lake Sharpe proper; and (3) Lake Sharpe tailrace and the 9.6 km upper extremity of Lake Francis Case (no area estimate for zone 3 was provided). Results of the aerial survey yielded estimates of the total angling hours expended in each zone and in each angling mode (Table 15).

Although no estimates were provided in the creel survey report, the number of angler-trips were calculable from tabulated monthly data for trip length and from graphs of monthly angling pressure in hours. The estimated

Table 15.-- Estimated total fishing pressure (fisherman-hours) by zone and mode of fishing, Lake Sharpe, South Dakota, June 1, 1973 through May 31, 1974

Area	Type of fishing						
	Boat	Shore	Ice	Spear	Snag	Total	%
Oahe tailwater	44,177	27,012	1,526	0	0	72,715	21.38
Lake Sharpe	110,389	57,643	1,877	965	0	170,874	50.24
Lake Sharpe tailwater	48,554	36,959	6,352	0	4,677	96,542	28.38
Total	203,120	121,614	9,755	965	4,677	340,131	100.00
%	59.72	35.75	2.87	0.28	1.37	100.00	

numbers of angler trips for each zone and angling mode are presented in Table 16. The 1973-1974 creel survey reported a total harvest of 113,801 fish (±12.46% at 95% confidence level). Five species combined to provide 95.8 percent of the total harvest. These species and their individual contributions were walleyes (81.9 percent), white bass (6.1 percent), channel catfish (3.8 percent), saugers (2.2 percent), and northern pike (1.8 percent). These statistics include the Big Bend tailwater fishery. Evaluation of the walleye sport fishery for the Lake Sharpe-supported segment only (reservoir proper and Oahe tailwater), provides an estimated total harvest of 70,952 walleyes and an average catch rate of 0.29 walleyes per angler-hour.

Abundance of non-game fish, such as carp, declined after initial impoundment. Of seven non-game fish species studied during the period 1964-1969 (goldeye, carp, river carpsucker, blue sucker, smallmouth buffalo, bigmouth buffalo, shorthead redhorse) only goldeyes, shorthead redhorse, and carp have produced significant year-classes since impoundment; carp did so, however, only during the first year the lake was filled (55). Subsequent year-classes of carp were smaller, a circumstance probably resulting from loss of spawning habitat. Cold-water discharges from Oahe may have adversely affected reproduction of all of these non-game fish species, particularly the current-seeking species like river carpsuckers, shorthead redhorse, and blue suckers.

Prior to construction of Lake Sharpe, both the Fort Randall tailwater and the Oahe tailwater provided unique snag-fisheries for paddlefish. During the 1958-1959 mid-winter snagging season, 4,491 paddlefish were harvested from the Fort Randall tailwater (56). In the 1960-1961 and 1961-1962 seasons, 3,698 and 3,657 paddlefish were harvested, respectively, from the

Table 16.--Estimated total fishing pressure (fisherman-trips) by zone and mode of fishing, Lake Sharpe, South Dakota, June 1, 1973 through May 31, 1974

Area	Type of fishing						
	Boat	Shore	Ice	Spear	Snag	Total	%
Oahe tailwater	10,650	11,313	1,187	0	0	23,150	25.38
Lake Sharpe	25,098	21,349	721	194	0	47,362	51.94
Lake Sharpe tailwater	9,208	8,875	833	0	1,768	20,684	22.68
Total	44,956	41,537	2,741	194	1,768	91,196	100.00
%	49.30	45.55	3.00	.21	1.94	100.00	

Oahe tailwater area. A change in operation of the Oahe Reservoir in 1962-63 (the area of paddlefish concentration was placed off limits to anglers by the Corps of Engineers) was associated with a severe reduction in the number of paddlefish harvested -- to approximately 420 fish (57).

The 1973-1974 creel survey of Lake Sharpe and the Oahe and Lake Sharpe tailraces reflected a complete lack of snagging effort for paddlefish, and zero-harvest in the Oahe tailrace, and a harvest of 399 paddlefish from the Lake Sharpe tailrace. A dramatic change in average weights of paddlefish harvested has occurred over time. The 420 fish harvested at the Oahe tailrace in 1962-63 averaged 18.6 lbs., while the 399 fish harvested from the Lake Sharpe tailrace in 1973-74 averaged 61.8 lbs. Older and larger fish supported the fishery in 1973-74 indicating interim failure of recruitment.

Fishery Resources -- Evaluation of Planning Input

Many of the post-impoundment fisheries predictions were related to the cooling effect that Oahe Reservoir was expected to have on the waters of Lake Sharpe. The resultant anticipated temperature regime of Lake Sharpe was expected to favor development of a trout fishery. Post-construction angler exploitation based on a trout fishery was projected at 111,000 fishermen days per year.

Post-impoundment investigations indicated that large areas of Lake Sharpe were physicochemically suitable for survival of the more temperature-tolerant salmonid species. However, two occurrences combined to prevent establishment of a salmonid fishery at Lake Sharpe. Although 3.3 million trout were stocked immediately after the lake was filled, the fish were released when the receiving waters were of poor quality and, in some areas,

where there occurred large concentrations of predaceous fish and bird life. Short-term survival of the planted trout was very low. At the same time the trout were being planted, reproduction of northern pike and walleyes was highly successful, with large year-classes of both species being established. No later attempt was made to superimpose a trout population on the rapidly expanding populations of northern pike, walleyes and other coolwater (mid-range) species.

All pre-construction predictions of the post-impoundment sport fishery became moot when the trout fishery failed to develop. No alternative quantitative estimates were provided based on development of a warmwater fish community. Qualitatively, any warmwater fishery provided by the impoundment was expected to be comprised of slow-growing fish. Fishing demand based on such a fish community was expected to be very low.

Post-impoundment studies have demonstrated that growth rates of walleyes, the dominant species in the Lake Sharpe sport fish community, could not be characterized as slow. Walleye growth rates did begin to decline about four years after reservoir impoundment. This decline was most pronounced among fish in the lower end of the reservoir, where reservoir water temperatures were at their highest. The reduced growth rates were associated with greater abundance of walleyes relative to densities of prey species in the lower end of the reservoir. Although slower in 1971 than in 1964, walleye growth rates continued to be comparable to growth rates in other traditional walleye waters such as Lake Oneida (58).

Angler use of the reservoir was projected at 111,000 man-days annually, based on the establishment of a trout fishery. The expected level of fishermen use of a warmwater fishery was not indicated in quantitative

terms, but was described as "greatly restricted." No information in the pre-impoundment predictive report allowed indentification of the precise area covered by the projected level of fishing activity. The Oahe tailwater fishery study, conducted by the SDGFPD from July,1959, to June, 1962, provided an average angler-use estimate at 48,685 trips per year (57). The first three years' results of this survey (averaging 54,953 trips/year) were available to the FWS prior to release of the 1962 report. While alluding in several instances to the relative importance to the total project area of the Oahe tailwater fishery, a total of 11,000 angler-days was reported for the entire area despite the fact that available information indicated that 5 times as much fishing pressure was occurring on the Oahe tailwater. The pre-impoundment use estimate reported by the FWS obviously did not include consideration of the Oahe tailrace.

The post-impoundment creel survey (1973-1974) assessed the angler use separately for the three distinct components of the Lake Sharpe sport fishery. While the total reservoir complex supported approximately 91,200 angler-trips, only 50 percent occurred on Lake Sharpe. Approximately one-fourth of the total angling effort occurred on each of the two tailwaters (below Oahe and below Lake Sharpe). Combined angling pressure for the complex, exclusive of the Oahe Reservoir tailrace, was approximately 68,046 trips. Use of the warmwater sport fishery was thus less than the annual visitation of 100,000 trips associated in the pre-impoundment report with development of a trout fishery.

Attributing this lower-than-expected angling pressure to a poor warmwater sport fishery would not be substantiated by the Lake Sharpe creel survey

of 1973-1974. The Lake Sharpe-supported walleye fishery (excluding Lake Sharpe tailwater) maintained an average success rate of 0.29 walleyes harvested for each hour of angling effort. This compares well with generally-recognized "quality" walleye sport fisheries. Lake Escanaba, Wisconsin, maintained a success rate of 0.15 walleyes per hour for the period 1946 to 1969 (59). At Oneida Lake, New York, walleye fishermen averaged approximately 0.35 walleyes per hour (0.10 - 0.71) during the 1957-1958 to 1959-1960 seasons (60).

Post-impoundment investigations confirmed the pre-impoundment prediction that abundance of certain non-game species such as carp would be depressed by reservoir construction. It is also apparent that the concern expressed in the pre-impoundment report for the paddlefish fishery was well taken. The greatly increased average weight of paddlefish harvested in the project area after construction of Lake Sharpe confirms the difficulties of reproduction anticipated as a result of inundation of paddlefish spawning grounds.

SUMMARY

Lake Sharpe was created by the construction of Big Bend Dam on the Missouri River near Fort Thompson, South Dakota. The project was authorized in 1944 as part of the Pick-Sloan plan for the comprehensive development of the Missouri River Basin. Project purposes include hydroelectric power, flood control, navigation, and recreation. At conservation pool, Lake Sharpe covers 22,582 ha (55,800 ac) and extends 80 miles upstream from the dam. At flood pool, an additional 1,821 ha (4,500 ac) are flooded. The total project includes 32,353 ha (79,942 ac) of land and water.

The Fish and Wildlife Service (FWS) submitted fish and wildlife-related comments to the CE as early as 1958. In their early planning reports, the FWS requested acquisition of several large land tracts (including 20,200 acres within two Indian Reservations) to mitigate wildlife losses expected to occur as a result of project construction. These land acquisition plans were drastically curtailed when the Indian Tribes refused to sell any Reservation lands for purposes of fish and wildlife management.

After several preliminary reports, the FWS submitted their final fish and wildlife report in December, 1962. This document contained the final recommendations and resource projections for the Lake Sharpe project.

To mitigate project-occasioned losses to wildlife, the final FWS report recommended the acquisition and development of a wildlife management area of only 2,900 acres in the vicinity of De Grey. Although neither the State nor the CE objected to the merits of the wildlife mitigation plan submitted by the FWS, the South Dakota Department of Game, Fish and Parks Department (SDGFPD) assumed the position that land acquisition for the

wildlife management area should be accomplished only from willing sellers. The CE considered this restriction as being technically unsound and, although the FWS requested submittal of the proposal for decision to Congress, the CE declined to do so and terminated the land acquisition procedure in 1964.

In general, the project was expected to benefit fish resources and improve waterfowl habitat and waterfowl hunting. Other wildlife species were expected to suffer substantial losses. These losses were expected to exceed the gains anticipated for the fishery and waterfowl resources.

Waterfowl were considered to be the most important wildlife using the Lake Sharpe project site. Total migratory waterfowl use of the Missouri River reservoir system was not expected to change greatly after construction of Lake Sharpe. Construction of the Lake Sharpe project was expected to effect a redistribution of waterfowl use among the four reservoirs. The attraction of the additional lake surface was apparently underestimated as it is readily apparent that the waterfowl resource projections were too conservative.

The actual change in goose-use over the four-reservoir complex was difficult to determine definitely because of the different FWS & SDGFPD pre-impoundment use estimates. Comparison of the pre-impoundment estimate developed by FWS with the only post-impoundment estimate available (developed by the SDGFPD), indicated that no net change in goose-use of the reservoir complex has occurred since construction of Lake Sharpe. Comparison of the pre- and post-impoundment information developed by the SDGFPD, however, indicates that migratory goose utilization of the reservoir chain averaged 82 percent higher after construction of Lake Sharpe. Average use of the

entire reservoir complex by ducks has averaged approximately 73 percent higher in the 10 years since construction of Lake Sharpe than in the 9 years immediately preceding reservoir construction.

Waterfowl use of Lake Sharpe has far exceeded the levels anticipated in the FWS report. Prior to impoundment, the FWS projected a post-impoundment waterfowl use of some 280,000 goose-days and expected only a slight increase in duck-day use (pre-impoundment duck use was placed at 68,718 days). Post-impoundment waterfowl data computed by the SDGFPD indicates that Lake Sharpe has supported an average use approximating 479,861 goose-days annually and 1,549,000 duck-days during the fall and winter migratory season -- approximately 1.7 and 20 times respective greater use than was expected by geese and ducks.

Data available since 1967 indicate that post-impoundment goose hunting pressure associated with Lake Sharpe has averaged 10,055 hunter-days, and that harvest has averaged 5,243 geese annually. These figures reflect 82 percent greater use and 275 percent greater harvest than the levels predicted by the FWS. A much greater discrepancy existed between the projected and actual duck hunting pressure and harvest. Only slight increases were expected over the pre-impoundment levels, which were estimated at 700 hunter days and a harvest of 2,000 birds. The post-impoundment State data indicate the actual duck hunting pressure and harvest associated with Lake Sharpe has averaged approximately 4,623 hunter-days and 6,515 birds.

The big game community associated with the Lake Sharpe project site was expected to be severely damaged by the construction of Lake Sharpe. Only remnant populations were expected to remain after lake construction, and

a complete loss of deer hunting was foreseen in the vicinity of the project. The FWS concluded that losses to the deer population could not feasibly be mitigated and, therefore, made no recommendations for mitigation of the anticipated loss. Analysis of available information for pre-impoundment and post-impoundment periods indicated that actual losses incurred by the big game resources may have been less severe than predicted. Unfortunately, no big game data relating specifically to the project lands were available. Deer harvest and hunting pressure information were, however, available on a county-by-county basis. These county data were gathered by the SDGFPD through postal survey. Post-construction hunting pressure and harvest success for deer increased substantially in the three contiguous South Dakota counties lying east of the Missouri River.

The number of deer licenses sold each year increased from a pre-project average of 91 to a post-project average of 255 and the deer kill increased by 213 percent (from a pre-construction average of 55 animals to 172 animals after project construction). Available data did not permit corresponding comparison for the two counties lying west of the Missouri River.

Loss of upland game habitat was expected to result in the loss of pheasants, sharp-tailed grouse, prairie chickens, Hungarian partridges, cottontail rabbits, and fox squirrels. An estimated harvest reduction by 1,000 pheasants, 100 sharp-tailed grouse, and 1,500 of the other three species combined (mostly cottontail rabbits) was expected. The project losses were developed by determining the area of upland game habitat to be lost and multiplying by the average species harvests per square mile that were derived for the affected counties through the SDGFPD postal surveys.

This technique appears reasonable, although losses in hunting opportunity and harvest in peripheral areas attributable to the elimination of winter habitat as a result of project construction was not considered.

The pre-impoundment report indicated that the bottomlands lost to Lake Sharpe were extremely important winter cover for pheasants, sharp-tailed grouse, and prairie chickens. Pheasant populations in the five impacted counties have declined (as reflected by harvest and hunter success data) but at a lesser rate than for the State as a whole. Grouse populations, on the other hand, have improved at a greater rate over the entire State than in the five impacted counties. The available data did not permit an accurate appraisal of the reservoir's impact on upland game.

Treatment of the fishery aspects of the Lake Sharpe project was not adequate. The quantitative projections were based on the erroneous assumption that a trout fishery would develop; consequently, they had little relevance to the actual post-impoundment conditions. No alternative projections based on warm- or cool-water (mid-range) fisheries were presented. Based on the trout fishery expectation, 111,000 annual angler-days were predicted for Lake Sharpe. The net monetary increase was projected at $105,000 annually.

An early attempt was made to establish a trout fishery in Lake Sharpe. This attempt failed, but an excellent northern pike - walleye fishery developed rapidly without overt management assistance. No further attempt to superimpose a trout population on this naturally-developed cool-water community was made.

Based on the 1973-74 creel survey, Lake Sharpe (lake and tailwater) supported 68,046 fishermen trips. This level of angler use was 39 percent

less than the pre-impoundment prediction, which was projected on the basis of a trout fishery expectation. The FWS's prediction that any warmwater fishery which might develop at Lake Sharpe would be of poor quality, as reflected in the statement that such a fishery would receive "greatly restricted fisherman use," was overly pessimistic.

Post-impoundment fisheries investigations have documented some conditions that were accurately projected in the pre-impoundment report. Populations of certain non-game fish species, such as carp, buffalo, and redhorse, have declined since initial impoundment as predicted by the FWS. Paddlefish populations have been adversely affected by loss of critical river spawning habitat, also predicted by the State and FWS, as reflected in the increasing average weight of specimens harvested since Lake Sharpe was impounded.

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